

## BACKGROUND

The U.S. Census Bureau produces estimates of total resident population for each state and county on an annual basis. County population estimates are produced with a component of population change method, while the state population estimates are solely the sum of the county populations. The following documentation describes the work that is being carried out in the production of the July 1, 2003 total resident population estimates at the county level.

## OVERVIEW

The Census Bureau develops county population estimates with a demographic procedure called an "administrative records component of population change" method. A major assumption underlying this approach is that the components of population change can be closely approximated by administrative data in a demographic change model. In order to apply the model, Census Bureau demographers estimate each component of population change separately. For the population residing in households the components of population change are births, deaths and net migration, including net international migration. For the non-household population, change is represented by the net change in the population living in group-quarters facilities.

Each component in our model is represented with data that are symptomatic of some aspect of population change. For example, birth certificates are symptomatic of additions to the population resulting from births, so we use these data to estimate the birth component for a county. Some other components are derived from death certificates, Internal Revenue Service (IRS) data, Medicare enrollment records, Armed Forces data, group-quarters population data, and the American Community Survey (ACS).

In cases where we do not have data for all counties for the current estimate year, we estimate the components of population change based on one or more simplifying assumptions. When we prepare our initial population estimates, we use the same variant of the component model with these simplifying assumptions. In the creation of current vintage population estimates, we replace the initial population estimates from the previous vintage with "revised" population estimates calculated with the actual data for all components of population change. Calculations of "revised" population estimates also incorporate updates to components of change from previous years.

## METHOD

We produce the estimates of the county populations, starting with the base populations from either Census 2000 or the revised population estimate for the most recent year and then add or subtract the demographic components of population change calculated for the time period. Basically, we add the estimated number of births and subtract the estimated number of deaths for the time period. We then account for net migration, which is calculated using several components including: net internal migration, net foreign-born international migration, net movement to/from Puerto Rico, net Armed Forces movement, the change in group-quarters population, and native emigration from the United States.

We produce separate population estimates for the populations under age 65 and age 65 and older, mainly because different data are used to measure the internal migration of these two populations. For the population under age 65, we use data from individual IRS tax returns to calculate measures of migration. Because the population age 65 and older is not always well-represented on tax returns, we need to use a different source

(Medicare enrollment) to calculate measures of migration for this population. The following describes how we produce population estimates for these two populations.

## STEP 1: ESTIMATING THE POPULATION UNDER AGE 65

### 1A. Base Populations

1A-1. Total base population under age 65 - The total base population for the estimate of the population under age 65 is either the April 1, 2000 population estimates base or the revised county population estimate for the prior estimate year. For official population estimates, the April 1, 2000 population estimates base is not adjusted for census undercount.

In general, the April 1, 2000 population estimates base uses Census 2000 data as its base, but includes certain modifications (geographic updates, Count Question Resolution (CQR) changes, and updates to Tiger).

1A-2. Base group-quarters population under age 65 - The group-quarters population component is primarily a combination of military personnel living in barracks, college students living in dormitories and persons residing in institutions. Inmates of correctional facilities, persons in health care facilities and persons in Job Corps Centers are also included in this category. We have excluded persons age 65 and older residing in nursing homes and other facilities from this category since they are included in the estimate of the population age 65 and older. The base group-quarters population for the current estimate year is the revised group-quarters population from the prior estimate year. In the first estimate year following the decennial census, the base group-quarters population is the group-quarters population as enumerated in Census 2000.

1A-3. Base household population under age 65 - After we subtract the base group-quarters population under age 65 from the base total population under age 65 we have a residual that we call the base household population under age 65 by county. The general formula is as follows:

$$U65HP_{x-1} = AREST_{x-1} - (EX64_{x-1} + EPO65_{x-1} + GQ<65_{x-1})$$

Where:

U65HP	is the county base household population under age 65
AREST	is the total county population for all ages
EPO65	is the county population age 65 and older
GQ<65	is the county group-quarters population under age 65
EX64	is the county population age 64 in the previous estimate year (who will turn age 65 in the current estimate year).

Note: In the above formulas, x-1 denotes the previous estimate year

1A-4. Population base of potential internal migrants under age 65 - The population base of potential internal migrants is usually considered to be the midpoint population of the period since the population at the beginning of the estimate period has not yet experienced the births and deaths that are reflected in the population at the end of the period. Also, the population at the end of the estimate period includes in-migrants and excludes out-migrants. The best compromise is to take the population at the midpoint of the period.

Estimated resident births, estimated deaths to people under age 65, and net international migration are assumed to have been evenly distributed throughout the estimate interval and, therefore, have the potential for migration, on average, for one-half of the period. We develop the internal migration base under age 65 by adding one half of the following to the previous year's household base population under 65 years: estimated resident births minus estimated resident deaths under 65 years, plus estimated net international migration. The base internal migration population under age 65 is calculated using the following formula:

$$MBASE<65_x = U65HP_{x-1} + (.5 * (PB_x - PD<65_x + FBINAT<65_x - EMIG<65_x + NMPR<65_x))$$

Where:

MBASE<65 is the county population base of potential internal migrants under age 65  
U65HP is the county base household population under age 65  
PB are the county-level period births  
PD<65 are the county-level period deaths to the population under age 65  
FBINAT<65 is the county net foreign-born international migration of the population under age 65  
EMIG<65 is the county native emigration of the population under age 65  
NMPR<65 is the county net movement to/from Puerto Rico under age 65

Note: In the above formula -

x denotes the current estimate year  
x-1 denotes the previous estimate year

## 1B. Components of population change

1B-1. Resident births - Resident births are recorded by residence of mother, regardless of where the birth occurred; hence, a county need not have a hospital in order to have resident births.

1B-2. Resident deaths to population under age 65 - We use death data tabulated by the most recent residence of the decedent, regardless of where the death occurred.

1B-3. Net internal migration for population under age 65 - We estimate the net internal migration within the United States during the estimate interval. Our estimate includes household migration derived from Federal income tax returns and the change in the group-quarters population.

1B-3a. Migration from Federal Income Tax Returns - We use data from Federal income tax returns supplied by the Internal Revenue Service (IRS) to measure part of the internal migration of the population under age 65. These data are limited to filers and their exemptions who are under age 65. We derive net internal migration rates using these data and then apply these rates to the household population under age 65.

Part 1. Internal Migration Rate - The net internal migration rate for the household population under age 65 for each county is calculated using the following formula, which is based on the difference between the in-

migration and out-migration of tax filers and their dependents:

$$\text{NiMR}<65_x = [(\text{INST}_x + \text{INCTY}_x + \text{INFOR}_x) - (\text{OUTST}_x + \text{OUTCTY}_x + \text{OUTFOR}_x)] / (\text{NON}_x + \text{OUTST}_x + \text{OUTCTY}_x + \text{OUTFOR}_x)$$

Where:

NiMR<65	is the county net internal migration rate for the household population under age 65
INST	are the county in-migrants from another state
INCTY	are the county in-migrants from another county within the same state
INFOR	are the county in-migrants from a foreign location
OUTST	are the county out-migrants to another state
OUTCTY	are the county out-migrants to another county within the same state
OUTFOR	are the county out-migrants to a foreign location
NON	are the county nonmigrants

Part 2. Net internal migration - Net migration for the population under age 65 is the product of the net internal migration rate (NiMR<65) and the base internal migration population under age 65, as calculated using the following formula:

$$\text{MIG}<65_x = (\text{MBASE}<65_x * \text{NiMR}<65_x) - \text{AF}<65_x$$

Where:

MIG<65	is the county net internal migration of the household population under age 65
MBASE<65	is the county population base of potential internal migrants under age 65
NiMR<65	is the county net internal migration rate for the household population under age 65
AF<65*	is the county net Armed Forces movement under age 65

If the net migration (MIG<65) is negative (-), then the figure indicates net out-migration of the household population; otherwise, the figure represents net in-migration.

\* The net internal migration rate for the household population under age 65 (NiMR<65) includes in- and out-migrations to/from a foreign location. Our assumption is that the in- and out-migrants to/from a foreign location who file independent tax returns are mostly Armed Forces. Therefore, we take the Armed Forces movement component for the population under age 65 (AF<65) out of the net internal migration of the household population under age 65 (MIG<65). See section 1B-4 for a description of how we calculate AF<65.

1B-3b. Migration from Change in Group-Quarters Population - We use data on the change in the group-quarters population to measure part of the internal migration of the population under age 65. We use group-quarters population data from two sources to estimate county populations: (1) Census 2000 counts of group-quarters population by

single year of age and facility type for each subcounty area, and (2) a time series of individual group-quarters records from the Group Quarters Report (GQR). Subcounty areas are commonly referred to as places, cities, towns, etc. These areas represent functioning governmental units and residual pieces thereof.

These two sets of group-quarters population data are used to derive a time series of group-quarters population through the following process:

Part 1. We sum the group-quarters populations from Census 2000 (total under age 65 only) and the GQR to the subcounty level by the seven facility types for each estimate date in the time series.

Part 2. We derive the total group-quarters population under age 65 by GQ type from the summarized GQR data using age distribution data from Census 2000 in the following formula:

$$GQR<65_{x,t} = (GQ<65_{C2000,t} / GQ_{C2000,t}) * GQRTOT_{x,t}$$

Where:

GQR<65	is the subcounty GQR population under age 65
GQ<65	is the subcounty group-quarters population under age 65
GQ	is the subcounty group-quarters population of all ages
GQRTOT	is the subcounty GQR population of all ages

Part 3. The time series of subcounty group-quarters population under age 65 by GQ type is then calculated by adding the year to year change given by the GQR data, using the following formula:

$$GQ<65_{x,t} = GQ<65_{x-1,t} + (GQR<65_{x,t} - GQR<65_{x-1,t})$$

Where:

GQR<65	is the subcounty GQR population under age 65
GQ<65**	is the subcounty group-quarters population under age 65

\*\* Is the Census 2000 GQ population for the July 1, 2000 estimate

Part 4. The subcounty numbers are summed to the county level for the calculation of county population estimates.

Note: In the above formulas-

C2000	denotes a Census 2000 reference date
x	denotes the current estimate year
x-1	denotes the previous estimate year
t	denotes facility type (correctional institutions, juvenile facilities, nursing homes, other institutional, university dormitories, military barracks, other noninstitutional)

1B-4. Net international migration for population under age 65 – We estimate the net international migration to/from the United States from several sources. Our

estimate includes the net foreign-born international migration, net movement to/from Puerto Rico, net Armed Forces movement, and native emigration.

1B-4a. Net foreign-born international migration - National-level data on the net foreign-born international migration of the population under age 65 for the current estimate period are distributed to counties based on the county distribution of the non-citizen foreign-born population who entered the U.S. during the 5 years prior to April 1, 2000 from Census 2000 using the following formula:

$$FBINAT<65_{NAT,x} = NFBINAT<65_{NAT,x} * (FB<65_{NAT,C2000} / NFB<65_{NAT,C2000})$$

Where:

FBINAT<65	is the county net foreign-born international migration under age 65
NFBINAT<65	is the national net foreign-born international migration under age 65
FB<65	is the county non-citizen foreign-born population under age 65 who entered the U.S. during the five years prior to April 1, 2000
NFB<65	is the national non-citizen foreign-born population under age 65 who entered the U.S. during the five years prior to April 1, 2000

1B-4b. Net movement from Puerto Rico - National-level data on the total net movement of the population under age 65 to or from Puerto Rico for the current estimate period are distributed to counties based on the county distribution of the Puerto Rican population who entered the U.S. during the five years prior to April 1, 2000 from Census 2000 using the following formula:

$$NMPR<65_x = NATNMPR<65_x * (PR<65_{C2000} / NATPR<65_{C2000})$$

Where:

NMPR<65	is the county net movement to/from Puerto Rico under age 65
NATNMPR<65	is the national net movement to/from Puerto Rico under age 65
PR<65	is the county population under age 65 born in Puerto Rico who entered the U.S. during the five years prior to April 1, 2000
NATPR<65	is the national population under age 65 born in Puerto Rico who entered the U.S. during the five years prior to April 1, 2000

1B-4c. Armed Forces movement - County-level data on net overseas movement of Armed Forces under age 65 for the current estimate period are derived using a three-stage process. First, the national-level total Armed Forces station strength data are distributed to states using Armed Forces

data originally supplied by each branch of the service. Second, these state-level data are distributed to counties using the military employment data from Census 2000. Raking occurs at the final step to control county-level data to national-level data.

1B-4d. Native emigration from the United States - National-level data on the total number of emigrants from the United States under age 65 for the current estimate period are distributed to counties based on the county distribution of the native-born population from Census 2000 using the following formula:

$$EMIG<65_x = NATEMIG<65_x * (NATIVE<65_{C2000} / NATNATIVE<65_{C2000})$$

Where:

EMIG<65	is the county native emigration of the population under age 65
NATEMIG<65	is the national native emigration of the population under age 65
NATIVE<65	is the county native-born population under age 65
NATNATIVE<65	is the national native-born population under age 65

Note: In the above formulas -

C2000 denotes a Census 2000 reference date

x denotes estimate year

#### 1C. Calculating the Population Under Age 65

The formula for estimating the county population under age 65 from the base populations and the components of population change is as follows:

$$U65_x = U65HP_{x-1} + PB_x - PD<65_x + MIG<65_x + GQ<65 + FBINAT<65_x - EMIG<65_x + NMPR<65_x + AF<65_x$$

Where:

U65	is the total county population under age 65
U65HP	is the county base household population under age 65
PB	are the county-level period births
PD<65	are the county-level period deaths to the population under age 65
MIG<65	is the county net internal migration of the household population under age 65
GQ<65	is the county group-quarters population under age 65

FBINAT<65 is the county net foreign-born international migration of the population under age 65  
EMIG<65 is the county native emigration of the population under age 65  
NMPR<65 is the county net movement to/from Puerto Rico under age 65  
AF<65 is the county net Armed Forces movement under age 65

Note: In the above formula -

x denotes the current estimate year

x-1 denotes the previous estimate year

Note: All components of population change are rounded to the nearest whole number. Where applicable, the differences between the sum of rounded components and the independently produced national components are added to or subtracted from the components for Los Angeles County, California (county with the greatest population in the U.S.).

## STEP 2: ESTIMATING THE POPULATION AGE 65 AND OLDER

### 2A. Base Populations

2A-1. Base total population age 65 and older - The total base population for the estimate of the population age 65 and older is either the Census 2000 base (for July 1 population estimate in the decennial year) or the revised county population estimate for the prior estimate year. See section 1A-1 for a more detailed explanation of the changes to the Census 2000 base population.

2A-2. Base group-quarters population age 65 and older - This component is primarily a combination of persons age 65 and older residing in nursing homes and other facilities and persons residing in institutions. Inmates of correctional facilities, persons in health care facilities, and Armed Forces living in barracks are all included in this category. The base group-quarters population for the current estimate year is the revised group-quarters population from the prior estimate year. In the first estimate year following the decennial census, the base group-quarters population is the group-quarters population as enumerated in Census 2000.

2A-3. Base household population age 65 and older - After we subtract the base group-quarters population age 65 and older from the base total population age 65 and older, we have a residual that we call the base household population age 65 and older. The basic formula is as follows:

$$O65HP_{x-1} = EPO65_{x-1} + EX64_{x-1} - GQ65+_{x-1}$$

Where:

O65HP is the county base household population age 65 and older

EPO65 is the county population age 65 and older

EX64 is the county population age 64 in the previous estimate year (who will turn age 65 in the current estimate year).

GQ65+ is the group-quarters population age 65 and older

In the above formula -

x-1 denotes the previous estimate year

2A-4. Population base of potential internal migrants age 65 and older - This population is derived using a slight modification of the calculation as used for the population under age 65\*\*\*. See section 1A-4 for a more detailed description. The basic formula is as follows:

\*\*\* These modifications are made because we assume that three components of net international migration age 65 and older (net movement to/from Puerto Rico, Armed Forces movement, native emigration) are not represented in the Medicare enrollment data used to derive the internal migration rate for the population age 65 and older.

$$OBASE65+_x = O65HP_{x-1} + (.5 * (AF65+_x - PD65+_x - EMIG65+_x + NMPR65+_x))$$

Where:

OBASE65+	is the county population base of potential internal migrants age 65 and older
O65HP	is the county base household population age 65 and older
AF65+	is the county net Armed Forces movement age 65 and older
PD65+	are the county-level period deaths to the population age 65 and older
EMIG65+	is the county native emigration of the population age 65 and older
NMPR65+	is the county net movement to/from Puerto Rico age 65 and older

Note: In the above formula -

x	denotes the current estimate year
x-1	denotes the previous estimate year

## 2B. Components of population change

2B-1. Resident deaths to population age 65 and older - We use death data tabulated by the most recent residence of the decedent, not by the place where the death occurred.

2B-2. Net internal migration for population age 65 and older - We estimate the net internal migration within the United States during the estimate interval. Our estimate includes household migration derived from Medicare enrollment records and the change in the group-quarters population.

2B-2a. Migration from Medicare Enrollment - We use the tabulations of the number of Medicare enrollees in each county obtained from the Centers for Medicare and Medicaid Service (CMS) to calculate the net internal migration rate. Comparable to IRS data used for the population under age 65, Medicare enrollment data allow us to develop a separate estimate of internal migration for the population age 65 and older.

Part 1. Internal Migration Rate - We derive a net internal migration rate (NiMR65+) for the household population age 65 and older for each county, which is based on the difference between the in-migration and out-migration of Medicare enrollees using the following formula:

$$NiMR65+ = (MED_x * MEDCOV) - ((MED_{x-1} * MEDCOV) + EX64_x + AF65+_x)$$

$$+ \text{NMPR65+}_x - \text{EMIG65+}_x - \text{PD65+}_x) / \text{MED}_{x-1} * \text{MEDCOV}$$

Where:

NiMR65+ is the county net internal migration rate for the household population age 65 and older  
MED is the county number of Medicare enrollees  
EX64 is the county population age 64 in the estimate year (who will turn age 65 in the current estimate year)  
AF65+ is the county net Armed Forces movement age 65 and older  
NMPR65+ is the county net movement to/from Puerto Rico age 65 and older  
EMIG65+ is the county native emigration of the population age 65 and older  
PD65+ are the county-level period deaths to the population age 65 and older  
MEDCOV is the Medicare coverage rate which is calculated using the following formula:

$$\text{MEDCOV} = \text{MED}_{2000} / \text{POP65+}_{C2000} * \text{COVUPDATE}$$

Where:

MED is the county number of Medicare enrollees  
POP65+ is the county population age 65 and older  
COVUPDATE is a national level ratio of medicare coverage in the estimate year to medicare coverage in the last census year.

Part 2. Net internal migration – Net migration for the population age 65 and older is the product of the net internal migration rate (NiMR65+) and the base internal migration population age 65 and older minus the Armed Forces movement, net movement from Puerto Rico plus the native emigration.

$$\text{MIG65+}_x = (\text{OBASE65+}_x * \text{NiMR65+}_x) - (\text{AF65+}_x + \text{NMPR65+}_x - \text{EMIG65+}_x)$$

Where:

MIG65+ is the county internal migration of the household population age 65 and older  
OBASE65+ is the county population base of potential internal migrants age 65 and older  
NiMR65+<sub>x</sub> is the county net internal migration rate for the household population age 65 and older  
AF65+ is the county net Armed Forces movement age 65 and older  
NMPR65+ is the county net movement to/from Puerto Rico age 65 and older  
EMIG65+ is the county native emigration of the population age 65 and older

Note: In the above formulas -

x denotes the current estimate year  
x-1 denotes the previous estimate year  
C2000 denotes a Census 2000 reference date  
2000 denotes a calendar year 2000 reference date

If the net migration (MIG65+) is preceded by a minus sign (-), then the figure indicates net out-migration; otherwise, the figure represents net in-migration.

2B-2b. Migration from Change in Group-Quarters Population - The process we use to derive the group quarters change for the population age 65 and older is similar to that used for the population under age 65. See section 1B-3 for a more detailed description

2B-3. Net international migration for population age 65 and older - The process we use to derive the international migration for the population age 65 and older is similar to that used for the population under age 65. See section 1B-4 for a more detailed description.

## 2C. Calculating the Population Age 65 and Older

The formula for estimating the county population age 65 and older from the base population and the components of population change is as follows:

$$O65_x = O65HP_{x-1} - PD65+_x + MIG65+_x + GQ65+_x + FBINAT65+_x - EMIG65+_x + NMPR65+_x + AF65+_x$$

Where:

O65 is the total county population age 65 and older  
O65HP is the county base household population age 65 and older  
PD65+ are the county-level period deaths for the population age 65 and older  
MIG65+ is the county internal migration of the household population age 65 and older  
GQ65+ is the county group-quarters population age 65 and older  
FBINAT65+ is the county net foreign-born international migration of the population age 65 and older  
EMIG65+ is the county native emigration of the population age 65 and older  
NMPR65+ is the county net movement to/from Puerto Rico age 65 and older  
AF65+ is the county net Armed Forces movement age 65 and older

Note: In the above formula -

x denotes the current estimate year  
x-1 denotes the previous estimate year

Note: All components of population change are rounded to the nearest whole number. Where applicable, the differences between the sum of rounded components and the independently produced national components are added to or subtracted from the components for Los Angeles County, California (county with the greatest population in the U.S.).

## STEP 3: CALCULATING THE TOTAL POPULATION

### 3A. Raking the populations

Raking with a factor is used to ensure consistency between county population estimates and independent estimates of the national population.

3A-1. Raking the population under age 65 - The factor is the national estimate of the total population under age 65 divided by the sum of the estimated total population under age 65 for all counties in the nation. This factor is multiplied by each county population under age 65.

3A-2. Raking the population age 65 and older - The factor is the national estimate of the total population aged 65 and older divided by the sum of the estimated total population aged 65 and older for all counties in the nation. This factor is multiplied by each county population age 65 and older.

### 3B. Rounding the populations

After applying the factors to the populations under age 65 and age 65 and older, we may have population estimates with fractional results. To eliminate "fractional people", we round the population estimate to the nearest whole number. Where applicable, the differences between the sum of rounded population estimates and the independently produced national population estimates are added to or subtracted from the population for Los Angeles County, California (county with the greatest population in the U.S.).

### 3C. Administrative Components of Population Change (ACOC)

These changes include results of challenges to population estimates, special censuses, test censuses, and dress rehearsal censuses.

### 3D. Calculating the Total Population

The total population for each county is the sum of the raked population under age 65 and the raked population age 65 and older. And again, the total population for each state is the sum of the county populations in that state.

## SPECIAL SECTION: ESTIMATING THE THREE-MONTH PERIOD

The population estimate for the three-month period between April 1 and July 1 of the decennial census year is produced using the same method as above, but incorporates three-months of data instead of a full-year of data. The three-months of data are derived by taking one-quarter of the data for the period July 1, 1999 to June 30, 2000. The only exceptions to this approach are (1) the group quarters population – for which we assume no change in the April 1 group-quarters population and it is held constant until July 1, and (2) Armed Forces movement data – for which we use the monthly data for July 1.